The Changing Face of Renewable Energy

A Navigant Consulting Multi-Client Study

Presentation to:
U.S. Environmental Protection Agency
November 12, 2003

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Navigant Consulting completed a major renewable energy study in June 2003.

A cross section of energy players in the U.S. and Canada participated in the study….

The Changing Face of Renewable Energy

Participants:
We Energies
Ontario Power Generation
ARC Financial
Salt River Project
Puget Sound Energy
Hydro Quebec
Southern Company
and Others

Public Release Document
June 16, 2003

'Sun and Wind Will Be Sources For More Power in Next Decade'

Wall Street Journal
June 19, 2003

"…. Although renewables account for only 3% of the world's electricity supply, they are poised for explosive growth…to a projected $35 billion-a-year global industry in 2013…

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Our study covered many different aspects of the renewable energy industry.

Key Questions Addressed by the Renewable Energy Multiclient Study

- What is the outlook for renewable energy technologies and markets over the next ten years?
- What are the key issues associated with grid integration of renewable energy?
- What is the status and outlook for emissions and renewable energy attribute trading?
- How can companies create a successful business in the renewable energy space?
- What is the outlook for RPS and what constitutes a good RPS?
- What is the status and outlook for renewable energy funds?
- What are the key permitting issues associated with different renewable energy technologies?

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There are many common drivers that continue to shape the renewable energy market.

Renewable Energy Market Drivers

- Improving economics (competitiveness with conventional options)
- Energy security and diversity
- Economic development
- Emissions benefits
- Consumer support for environmentally friendly technologies
- Energy price volatility
- Government support
  - Renewable Portfolio Standards
  - Feed-in tariffs
  - Renewable Energy Funds
  - Production tax credits and other similar incentives
  - Net metering

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There are many common barriers that continue to shape the renewable energy market.

Renewable Energy Market Barriers

- High first costs
- Inconsistent government commitment to providing incentives
- Grid integration issues
  - Dispersed and/or remote nature of the resources is a mismatch with the current T&D infrastructure
  - Small-scale of application makes interconnection and permitting costly (e.g. PV)
  - Dispatchibility (for intermittent renewable energy technologies)
- Concerns over aesthetics, noise and environmental impact
- Uncertainty in Renewable Energy Certificate markets

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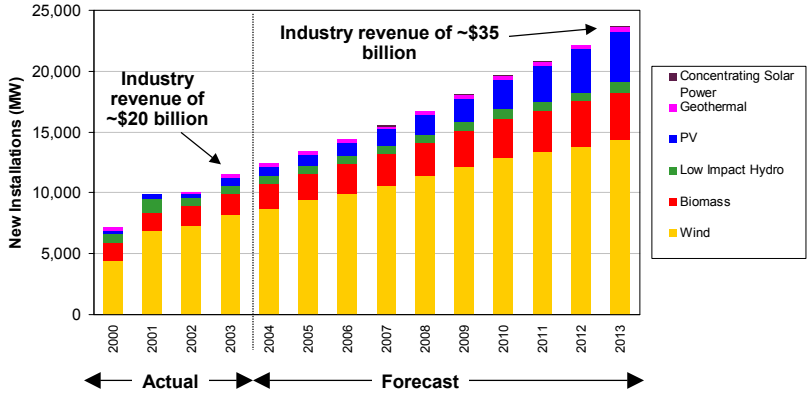
The renewable energy equipment business today is ~ $20 billion annually and is expected to reach ~ $35 billion by 2013.

Estimated Annual Worldwide Renewable Energy Capacity Additions (Business as Usual)*



*Excluding large hydro

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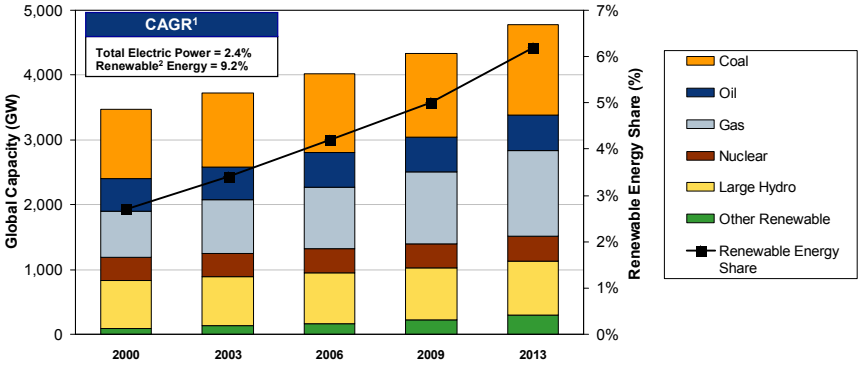
Renewable energy market share is expected to grow globally from ~3% in 2002 to 6% in 2013.

Estimated Worldwide Total Installed Power Capacity



Source: IEA *World Energy Outlook 2002* with NCI estimates of renewable energy, June 2003.
1. CAGR = Compounded Annual Growth Rate
2. Other renewable energy includes biomass, wind, photovoltaics, geothermal, low impact hydro, and concentrating solar power.

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For most of the renewable energy technologies, large corporations are staking out strong positions to capitalize on growth opportunities.

Examples of Large Corporate Players in Renewable Energy

Photovoltaics 	• Sharp • BP Solar • Kyocera • Shell Solar • Sanyo • RWE Schott Solar	**Low-Impact Hydropower** 	• GE Hydropower • ABB Alstom Power • VA Tech
Wind Power 	• Vestas/NEG Micon • Enercon • GE Wind • Mitsubishi • FPL Energy • National Wind Power • Shell Wind • ABB	**Concentrating Solar Power** 	• Solargenix Energy • Gamesa • Industrial Solar Technology • FPL Energy • Constellation • SMUD[3]
Biomass Power 	• Foster Wheeler • DTE Biomass • Caterpillar[1] • Waukesha[1] • Solar Turbines[1] • All pulp & paper co's[2]	**Geothermal** 	• Calpine • Caithness Energy • Ormat • Mitsubishi • Toshiba • Fuji

1. Suppliers of engines and gas turbines for landfill gas and biogas projects
2. Owners of most existing biomass power capacity in North America
3. Sacramento Municipal Utility District

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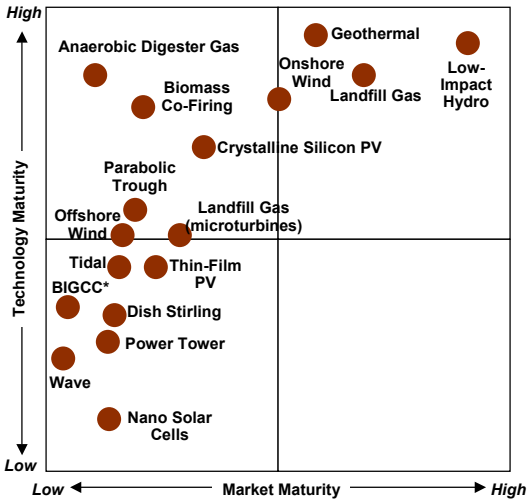
Many renewable energy options are now relatively mature technologically, but markets remain underexploited.

- **Technology maturity** describes the potential for performance improvements and/or cost reductions
  - — ***Low***: significant improvements expected in the next 10 years
  - — ***High***: incremental improvements expected in the next 10 years
- **Market maturity** describes the existence of well established business models, the presence of large players, the degree of saturation of the market potential, and the ability to obtain financing.
  - — ***Low***: emerging business models, fragmented market, minimal market penetration and/or high growth rates
  - — ***High***: well established business models, large companies with strong positions, moderate-high market penetration and/or growth rates similar to GDP growth



* Biomass integrated gasification combined cycle

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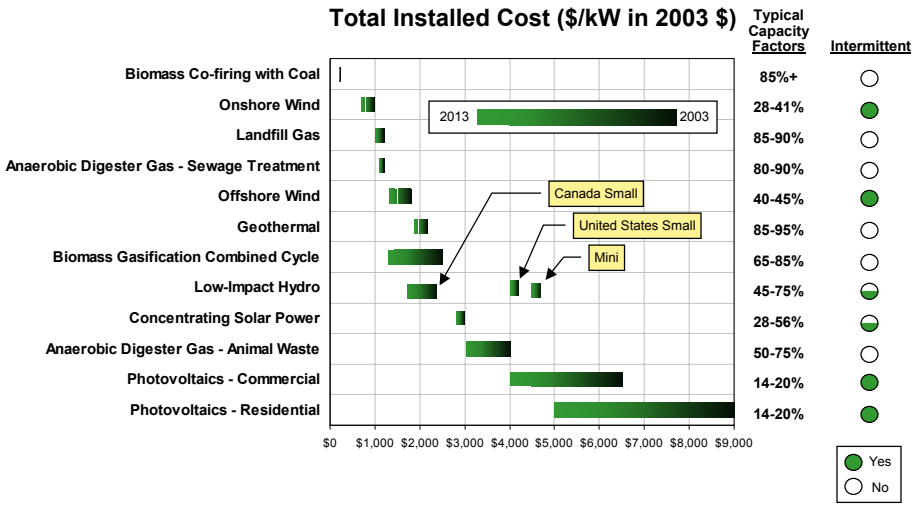
Future growth in renewable energy markets will be driven by reductions in total installed system costs.



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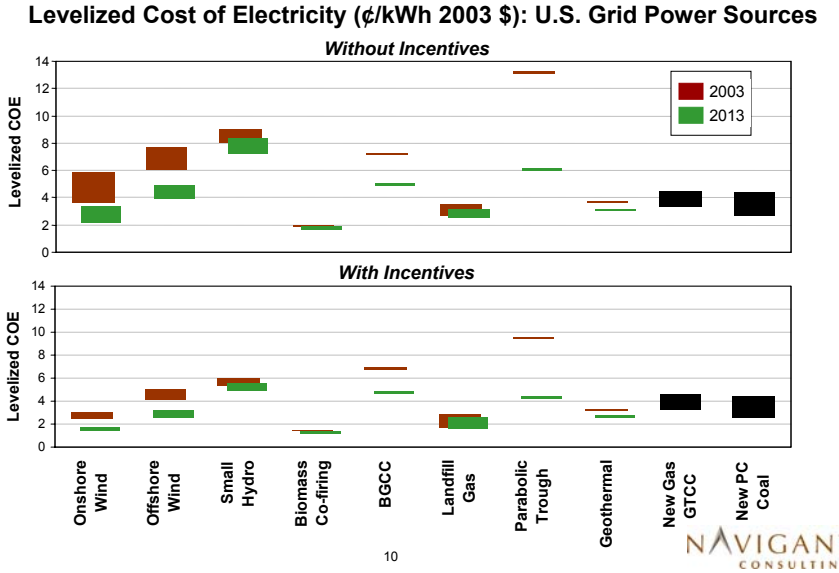
By 2013 most renewable energy options are expected to be competitive with grid power in the U.S. – Without Incentives.



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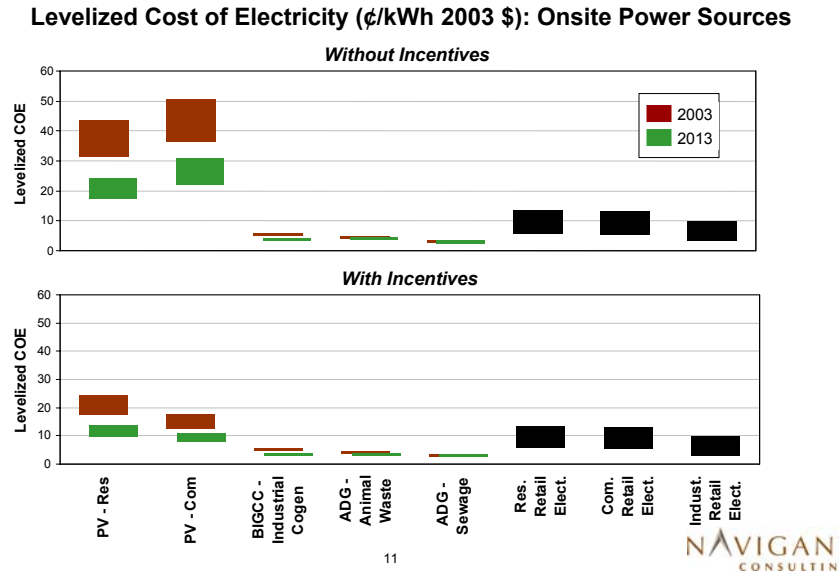
On-site use of biomass can be competitive with grid power today without incentives, whereas incentives are very important to the competitiveness of PV.



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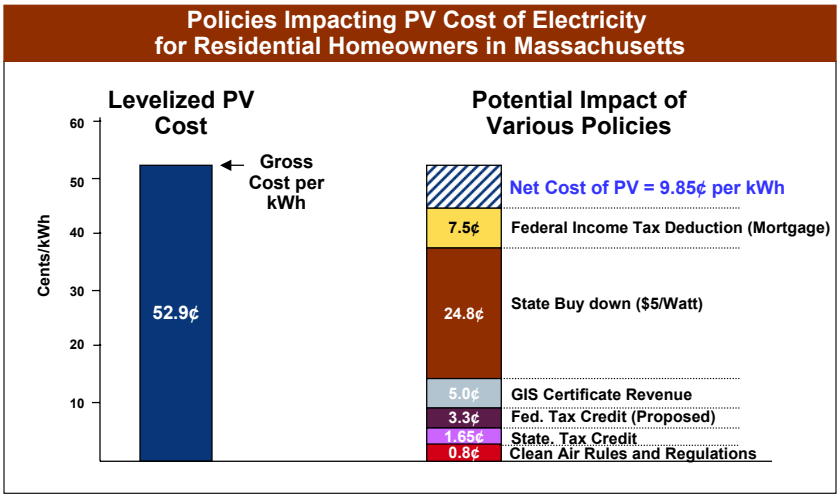
Many policies have been created in isolation, but cumulatively can result in PV and other renewables being competitive.



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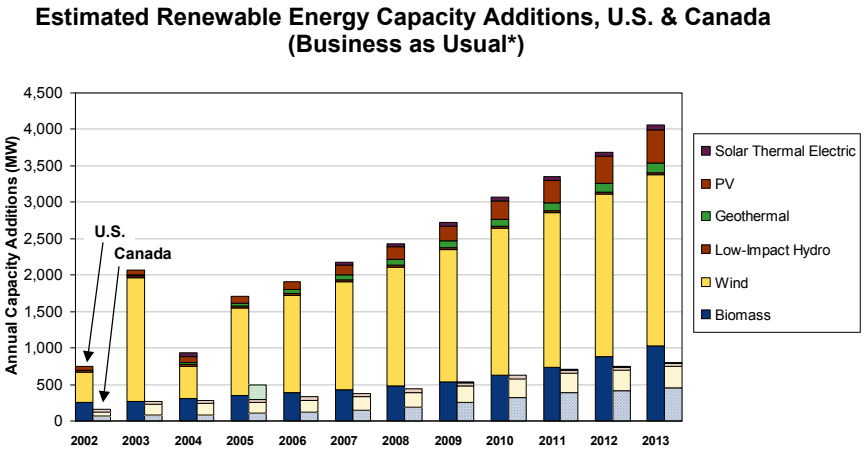
Annual U.S. installations of renewable energy are expected to increase from ~2,000 MW/yr in 2003 to ~4,000MW/yr in 2013.



*Assumes an extension of the Production Tax Credit for Wind by Summer 2004. If it is not passed by then, the estimates for 2004 would be even smaller in the U.S.

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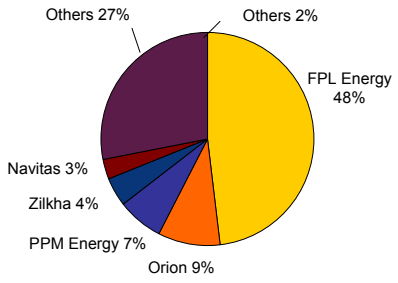
FPL Energy was the major U.S. wind developer and GE Wind was the leading wind turbine manufacturer in 2004.

U.S. Wind Installations By Developer (2003)

Total U.S. Installations = 1,687 MW



U.S. Wind Installations By Manufacturer (2003)

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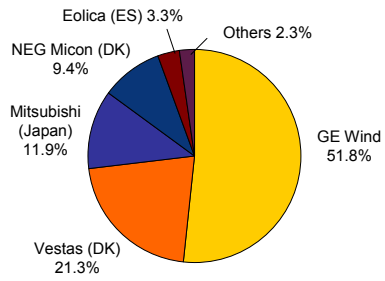

Source: NCI data based on AWEA and wind manufacturer interviews, March 2004.

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Market conditions for renewable energy technologies in the U.S. are as varied as the technologies themselves.

Wind	• Wind is expected to be the leading technology in terms of new additions over next 10 years. • Additions of 1,000-2,000 MW per year in the U.S., with off-shore wind beginning to see initial applications (assuming three year extension of the PTC). • Production tax credits and RPS requirements are expected to remain drivers of this growth.
Photovoltaics	• Continued robust growth, but economic attractiveness for grid-connected markets in the near-term requires government support and RPS requirements. • Some locations have extremely attractive incentives that can drive levelized cost of electricity from PV as low as 12.5 ¢/kWh, which approaches competitiveness with retail electricity rates.
Biomass	• Landfill gas leads in current opportunities, along with organic growth in biomass-based industries. • Large potential for co-firing and gasification, but market size and timing are uncertain. • Significant growth (%) expected in anaerobic digestion systems, but as a niche opportunity.
Low-Impact Hydro	• Significant untapped potential remains, but the U.S. market is expected to be small, absent major changes to the permitting and licensing process.
Geothermal	• Limited development expected absent changes to incentive programs: – Production Tax Credit for geothermal could result in increased market penetration
Solar Thermal Electric	• Minimal development expected due to continued high capital costs and no intermediate markets, unlike PV, which has cost-effective off-grid applications. Limited to areas of high direct solar insolation. • A potential advantage is the ability to incorporate storage to address intermittency issues.

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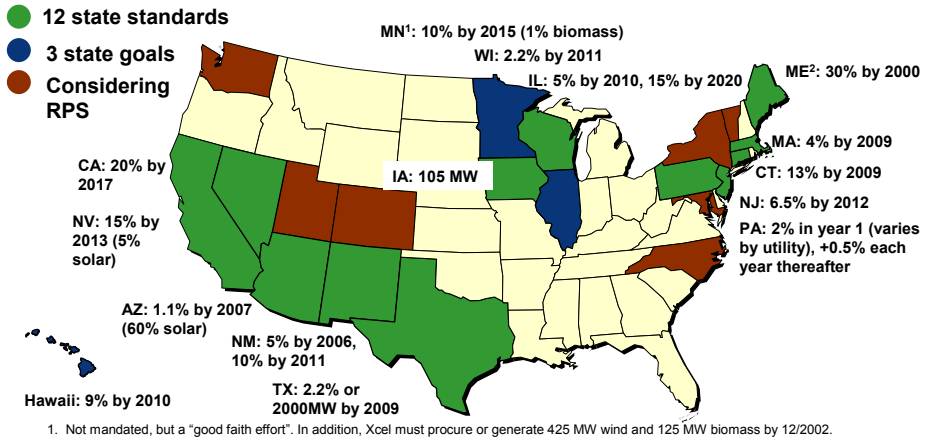
Today, 12 states have renewable portfolio standards and 3 others have renewable electricity "best effort" goals/targets.

U.S. Renewable Portfolio Standards (as of Feb. 2003)



1. Not mandated, but a "good faith effort". In addition, Xcel must procure or generate 425 MW wind and 125 MW biomass by 12/2002.
2. RPS includes existing resource and ME already gets >50% from renewables.

Note: NY requires that all state buildings achieve 20% by 2010. Gov. Pataki has also called for a 25% RPS by 2013; NYPSC has docket open.

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Eligible technologies for RPS vary significantly among the 15 states, but wind, photovoltaics, and biomass are included in all cases.

	Wind	Biomass	Hydro	PV	Geothermal	Landfill Gas	Solar Thermal Electric[1]	Ocean Thermal	Wave	Tidal	Waste	Cogeneration	Fuel Cells	Transportation Fuels	Waste Tire
ME	●	●	●	●			●			●	●	●	●	●	●
MA	●	●		●		●	●	●	●	●			●		
CT	●	●	●	●		●	●				●		●		
NJ	●	●	●	●	●	●	●		●	●	●		●		
PA	●	●		●	●	●	●				●				
WI	●	●	●	●	●		●		●	●			●		
IL	●	●		●											
MN	●	●	●	●											
IA	●	●	●	●							●				
TX	●	●	●	●	●	●			●	●					
NM	●	●	●	●	●	●	●						●		
AZ	●	●		●	●*		●								
NV	●	●		●	●		●								
CA	●	●	●	●	●	●	●				●				●
HI	●	●	●	●	●	●	●	●	●		●	●	●		

1. Equivalent to CSP (e.g., parabolic trough, power tower & dish Stirling)

* Geothermal Electric for AZ Public Service Co. only

Source: DSIRE website (www.dsireusa.org)

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Various benefits of renewable electricity are cited as justification for market intervention via RPS.

Intended RPS Benefits

- Environmental improvement
- Increased energy supply diversity, and greater reliance on domestic sources.
- Reduced volatility of power prices
- Economic development activity
- Reduced wholesale market prices
- Displacement of some gas-fired power with renewables, thereby helping to moderate gas prices.
- Adoption of a clear policy goal mobilizes government to take on other complementary actions to speed development of renewables.

Possible RPS Costs

- Renewable electricity may come at a higher cost than conventional power supplies.
- Intermittent nature of some renewables may require additional sources of back-up capacity or energy storage.
- Remote location on transmission grids for some renewable projects may impose higher transmission-related costs
- Some renewable projects may impose environmental externalities relating to real or perceived negative impacts on habitats, navigation, property values, views, noise, etc. Permitting and environmental approvals may substantially reduce -- but not completely eliminate -- these effects.

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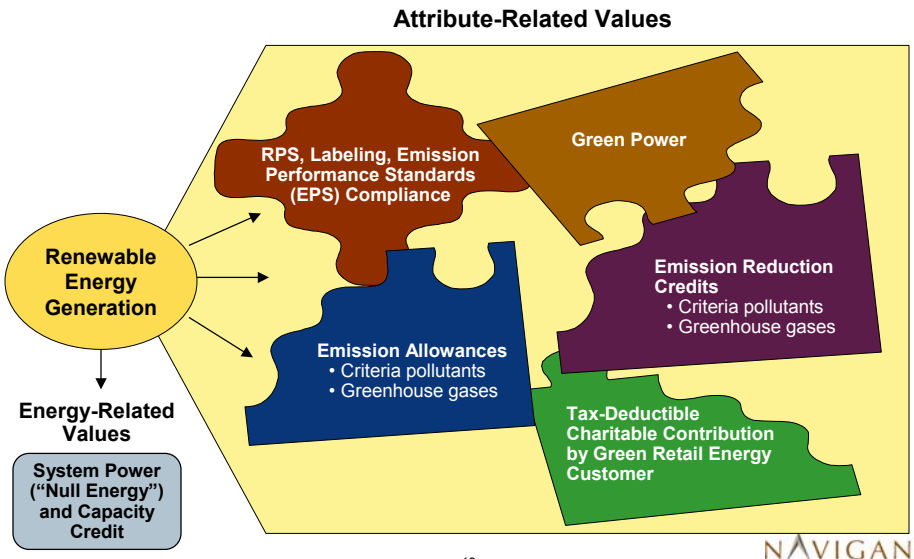
The market is beginning to value non-energy related attributes of renewable energy.



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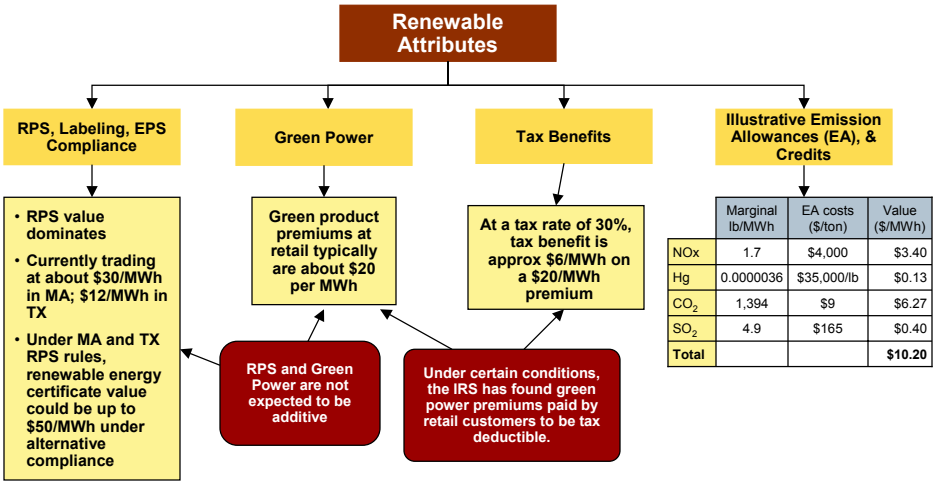
Renewable energy attributes have at least four value components that can add at least $10 - $50/MWh (1 – 5 ¢/kWh).



	Marginal lb/MWh	EA costs ($/ton)	Value ($/MWh)
NOx	1.7	$4,000	$3.40
Hg	0.0000036	$35,000/lb	$0.13
CO_2	1,394	$9	$6.27
SO_2	4.9	$165	$0.40
Total			**$10.20**

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Ownership of RECs relating to PURPA-era contracts has generated some legal controversies and petitions for clarification.

RECs Ownership Issues

- Cases have been filed with Maine PUC, Connecticut DPUC, and FERC seeking clarification on ownership of RECs associated with PURPA-era power purchase agreements (PPAs).
  - Utilities assert that "net electric output" of the Qualifying Facilities includes renewable attributes, such as RECs.
  - QFs assert that PPAs were silent with respect to RECS and, therefore, belong to the QFs.
- Maine PUC did not issue a decision on the REC petition, but addressed it substantively in an RPS update rulemaking. Allowed utilities that "cannot obtain clear title to RECs" to show compliance with RPS by contractual entitlement to electric power. PUC acknowledged potential double-counting problem.
- FERC reviewed petition by four waste-to-energy companies asserting ownership of RECs on PURPA-era contracts. FERC ruled 2-1 that PURPA does not inherently award RECs to either party and the ownership issue is subject to state review.
- Connecticut DPUC case is still pending.

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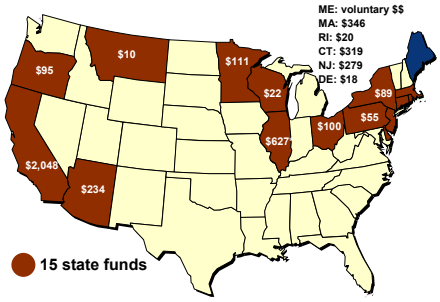
State renewable energy funds are expected to exceed $4.3 billion (cumulative) through 2012.

U.S. Renewable Energy Funds (as of 5/03)
(cumulative 1998 – 2012, in million $)



	Wind	Solar	Geothermal	Biomass	Landfill Gas	Ocean-based	Hydro	Fuel Cells	MSW
MA	●	●		●	●	●	●	●	●
RI	●	●		●			●	●	
CT	●	●		●	●	●		●	
NY	●	●	●	●			●	●	
NJ	●	●	●	●		●	●	●	
PA	●	●	●	●	●		●	●	●
DE	●	●	●						
OH	●	●	●	●			●	●	
IL	●	●		●			●		
WI	●	●	●	●		●	●	●	
MN	●	●		●			●	●	
MT	●	●	●	●			●		
AZ	●	●		●	●				
OR	●	●	●	●	●		●		●
CA	●	●	●	●		●	●	●	●

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Permitting of renewable energy power projects tends to follow different processes in different jurisdictions.

Onshore Wind	Permitting varies by local jurisdiction and state/province, but is likely to include local zoning and state and federal requirements. Numerous environmental issues need to be addressed.
Offshore Wind	Includes all permitting issues for onshore wind systems plus additional issues. Permitting rules and processes are being developed slowly, as applications for this new technology are being submitted in different parts of North America.
Photo-voltaics	Permitting is largely a local matter, with considerable variability among local zoning boards and building permit offices.
Biomass	Permitting is centered around air and water quality issues. For large projects, the process is similar to that for conventional power plants. For smaller systems, permitting may be solely a local issue, but may also include items not traditionally associated with power projects (e.g., animal waste management).
Small-Scale Hydro	U.S. permitting process includes a central role for FERC. Roles of other agencies differ by state and municipality. In general, the process is extensive, time-consuming, costly, and generally not cost-effective.

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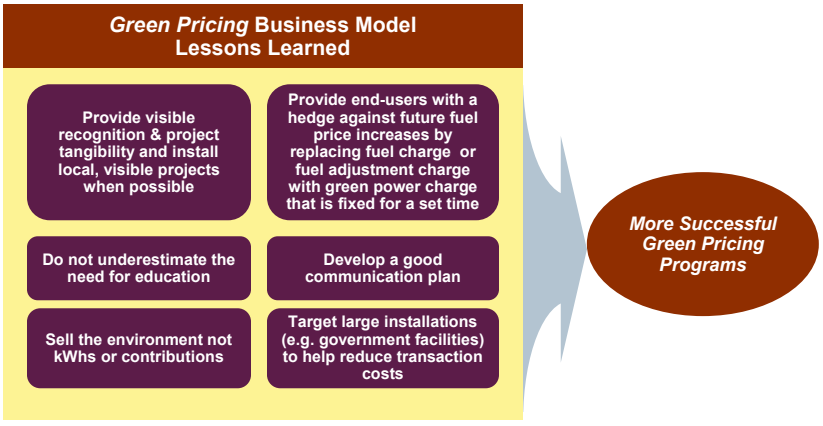
Green Pricing business models underscore the importance of awareness, education, communication and providing, when possible, a hedge against fuel price increases.



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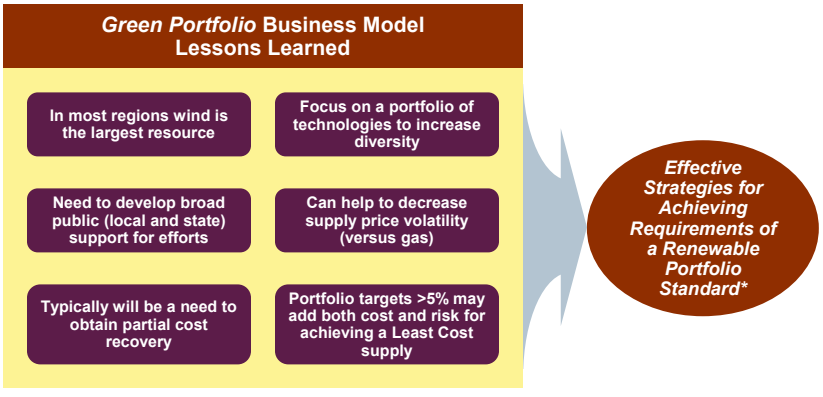
Achieving a renewable portfolio standard target will typically benefit from a diversified approach to reduce cost, and increase public support.



**Voluntary or mandated*

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There is tremendous growth that is expected for renewable energy over the next 10 years.

Continued technology improvements will help drive growth

Technology

- **Technology performance continues to improve.**
- **Many renewable energy technologies have experienced significant cost reductions and are approaching competitiveness with conventional power**
  - **Wind and PV are 1/10th the cost they were in the early 1980s and additional cost reductions of ~5% per year (real terms) are expected in the near-term**

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There is tremendous growth that is expected for renewable energy over the next 10 years.

Renewable energy attributes will add value, but appropriate subsidies/support will still be important

Markets

- **RPS – required in 12 states – are an important driver along with cost reductions**
- **RECs provide value beyond the energy value and are emerging as the dominant "currency" for complying with RPS and other renewable energy programs.**
- **Wind and PV markets have seen 15 – 25% annual growth over the past five years.**
- **Cumulative installed renewable energy capacity is expected to more than double over the next ten years in the U.S. and Canada, with wind and biomass comprising about 85% of the new capacity.**

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There is tremendous growth that is expected for renewable energy over the next 10 years.

Renewables represent an important growth opportunity for energy companies

Benefits/ Opportunities

- **Renewable energy markets are growing faster than conventional power worldwide (9.2% vs. 2.4% CAGR).**
- **Diversifies an energy supply portfolio and offers a hedge against rising gas prices**
- **Is easier to permit and build (more modular) compared to nuclear or coal plants**
- **Improved/lack of emissions have made renewable energy attractive for meeting global climate change concerns and reducing national emissions of criteria pollutants.**
- **The business is no longer niche, and currently represents a $17 billion/yr business worldwide that is expected to grow to $35 billion/yr by 2013 (equipment business only).**

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